Zero Boil-Off Tank Experiment (ZBOT)

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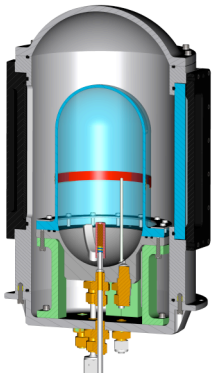
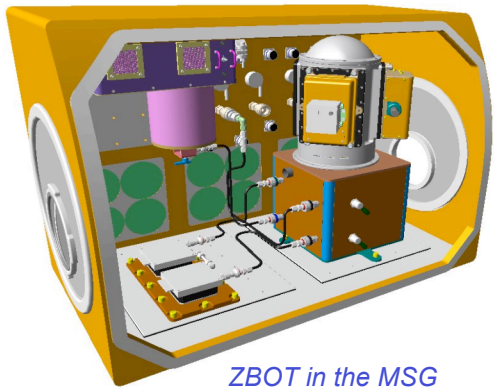


Test Tank inside the Vacuum Jacket



ZBOT in the MSG

Objective:

- Develop a small-scale simulant-fluid (Perfluoro-n-pentane) experiment for both preliminary ground-based testing and subsequent ISS flight experiments in order to obtain valuable microgravity empirical data for a ZBO tank design and archival science data for model validation.
- Build a science base for the future space storage tank engineering efforts by elucidating the roles of the various interacting transport and phase change phenomena that impact tank pressurization and pressure control in variable gravity through systematic 1g and microgravity scientific investigation.
- Develop, validate, and verify variable gravity two-phase CFD models for ventless ZBO storage tank pressure control that can be used to aid scale-up tank design.
- Show the feasibility of ZBO pressure control scheme for microgravity and variable gravity applications by examining the effect of forced mixing of the bulk liquid on destratification and pressure reduction.

Relevance/Impact:

- Reduces launch mass and decreases risks through enabling design concepts for long-term storage of cryogenic fluids.
- Cost effective and reliable cryogenic storage for both life support and propulsion systems satisfying the requirements for long term mission scenarios from Moon to Mars and beyond.

Development Approach:

- Ground phase: develop ground-based experiment and obtain 1-g data for tank pressurization and pressure control.
- Flight phase: develop ISS experiment and obtain microgravity data for tank pressurization and pressure control.
- Develop a state-of-the art two-phase CFD model for tank pressurization and pressure control.
- Validate and Verify (V&V) the CFD model with microgravity and 1g data.
- Use the validated CFD model and empirical correlations derived from the 1g and microgravity data for scale-up tank design.

ISS Resource Requirements

Accommodation (carrier)	Microgravity Science Glovebox (MSG)
Upmass (kg) (w/o packing factor)	80 - 100 kg
Volume (m^3) (w/o packing factor)	0.10 - 0.12 m^3
Power (kw) (peak)	0.100 kW
Crew Time (hrs) (installation/operations)	15 - 20 hrs. total
Launch/Increment	Increment 30

Project Life Cycle Schedule

Milestones	RCR	RDR	PDR	CDR	VRR	Phase III Safety	FHA	Launch	Ops	Return	Final Report
Actual/ Baseline	5/05	6/08	11/09	6/10	3/11	6/11	9/11	12/11	2-3/12	TBD	5/13
Documentation	Website: http://spaceflightsystems.grc.nasa.gov/ Advanced/ISSResearch/MSG/ZBOT/ eRoom: (R) Zero Boil-Off Tank Experiment				SRD: Version 3.9; May 7, 2008 EDMP: FY09 (planned for baseline)			Project Plan: January, 09 (planned for baseline) SEMP: FY09 (planned for baseline)			

Revision Date: 11/18/08